STOW-97
SYNTHETIC ENVIRONMENT

The Improved CGF Terrain DataBase Project (ICTDB) and Multiple Resolution Models in the Synthetic Environment

13 Aug 96

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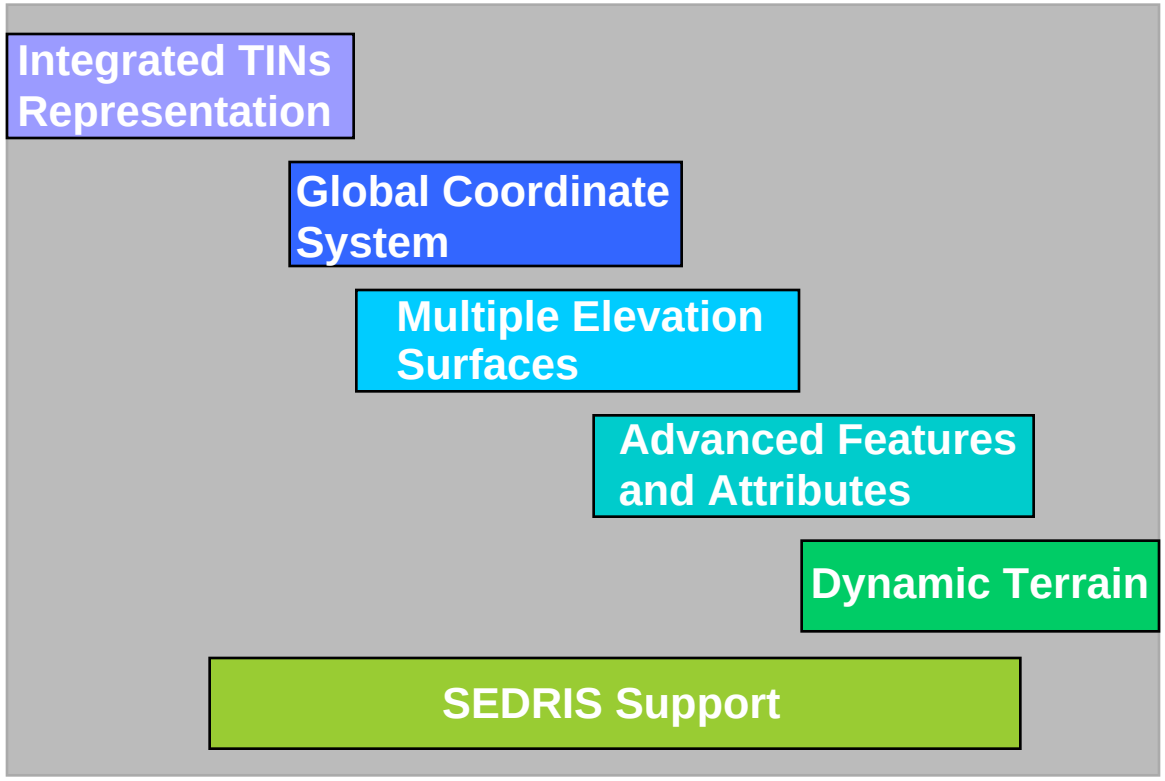
ICTDB PROJECT GOALS

- **Provide CGF terrain database representation that will satisfy the STOW requirements**
  - **High fidelity terrain and environment**
  - **Large geographic extents**
  - **Dynamic environment**
  - **Large numbers of entities**
- **Provide CGF terrain support for other STOW Synthetic Environment programs**
  - **Real-time atmosphere and ocean (WINDS/TAOS)**
  - **Dynamic terrain and objects (DTO)**
  - **Dynamic virtual worlds (DVW)**

ICTDB DEVELOPMENT TASKS



These technical advances have been and are being implemented in the Open SAF Compact Terrain DataBase (CTDB)

INTEGRATED TRIANGULATED IRREGULAR NETWORKS

- CTDB patches originally gridded with overlaid microterrain polygons
- Inefficient for completed TINed databases
- Hybrid Representation was developed
  - CTDB Patches can be either gridded representation or ITIN representation
    - Gridded representation similar to previous format
  - Compiler / Reformatter can determine best representation for patch
    - Can also be user specified for entire database

INTEGRATED TRIANGULATED IRREGULAR NETWORKS

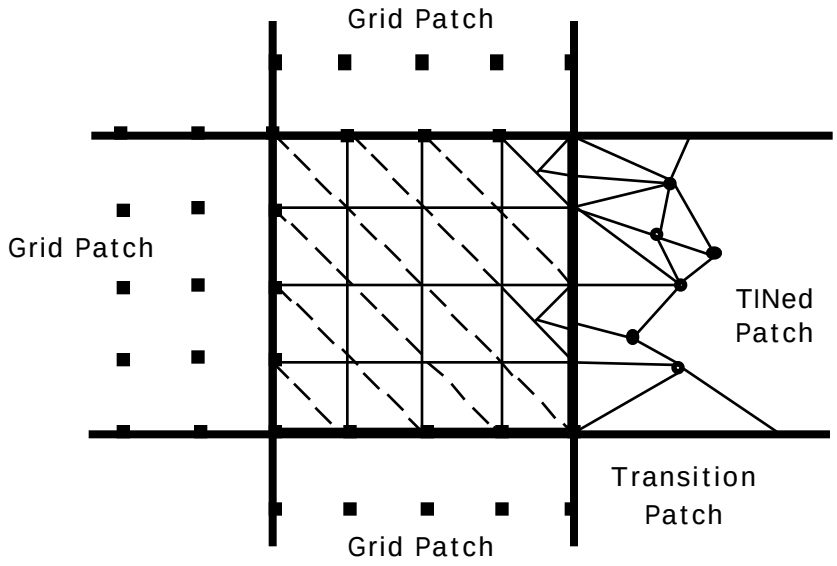
Three CTDB database types

- Pure TINed
  - TIN covers all of database extents
  - Every patch has significant microterrain
  - STOW-E
- Pure Gridded
  - Terrain based on regular grid
  - Some patches may have small amount of microterrain
  - Ft. Knox
- Hybrid
  - Two types
  - TIN covers portion of database extents
    - Range 400
  - Terrain based on regular grid, but many patches have significant microterrain
    - Ft. Hunter-Liggett

HYBRID REPRESENTATION

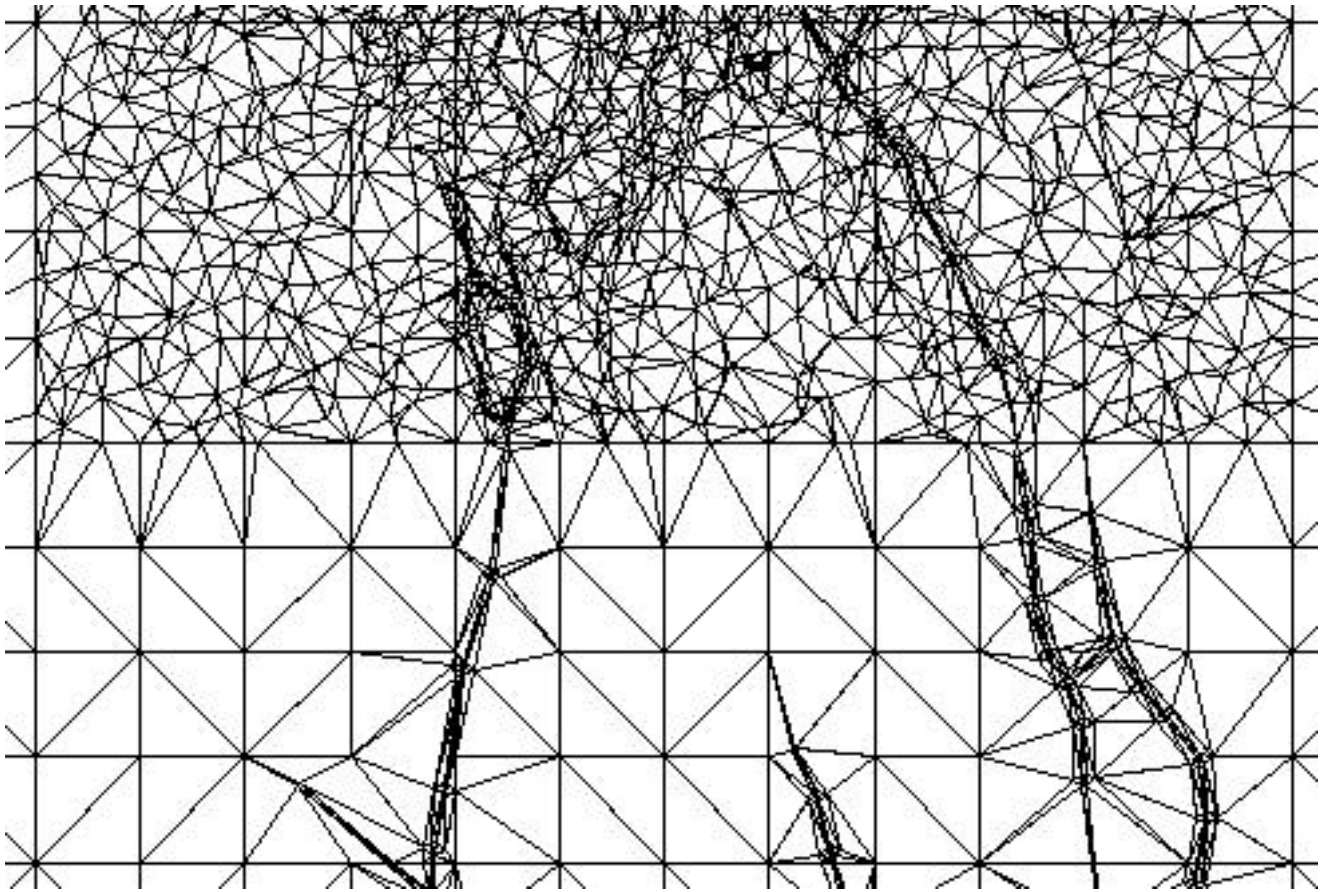
Transition patches

- Gridded patches that border TIN patches
- Converted to TINs so polygons align at edges
- Some retriangulation necessary along borders

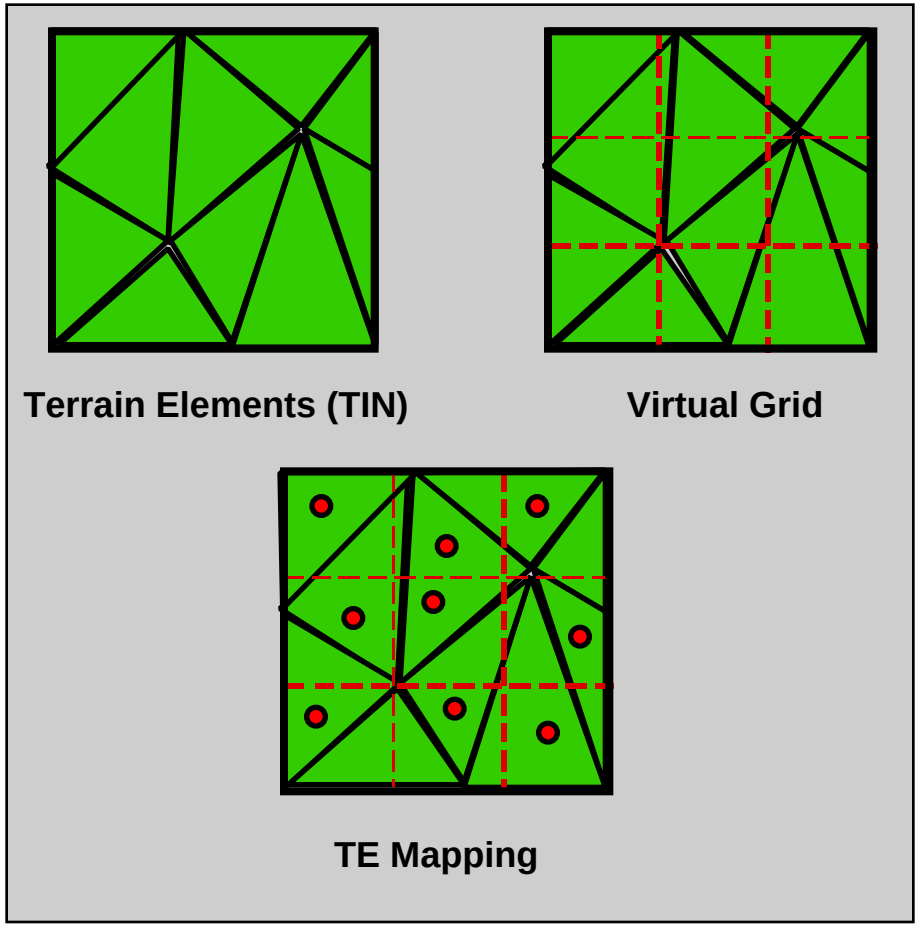


RANGE 400 DATABASE

Variable resolution per patch on TINed database

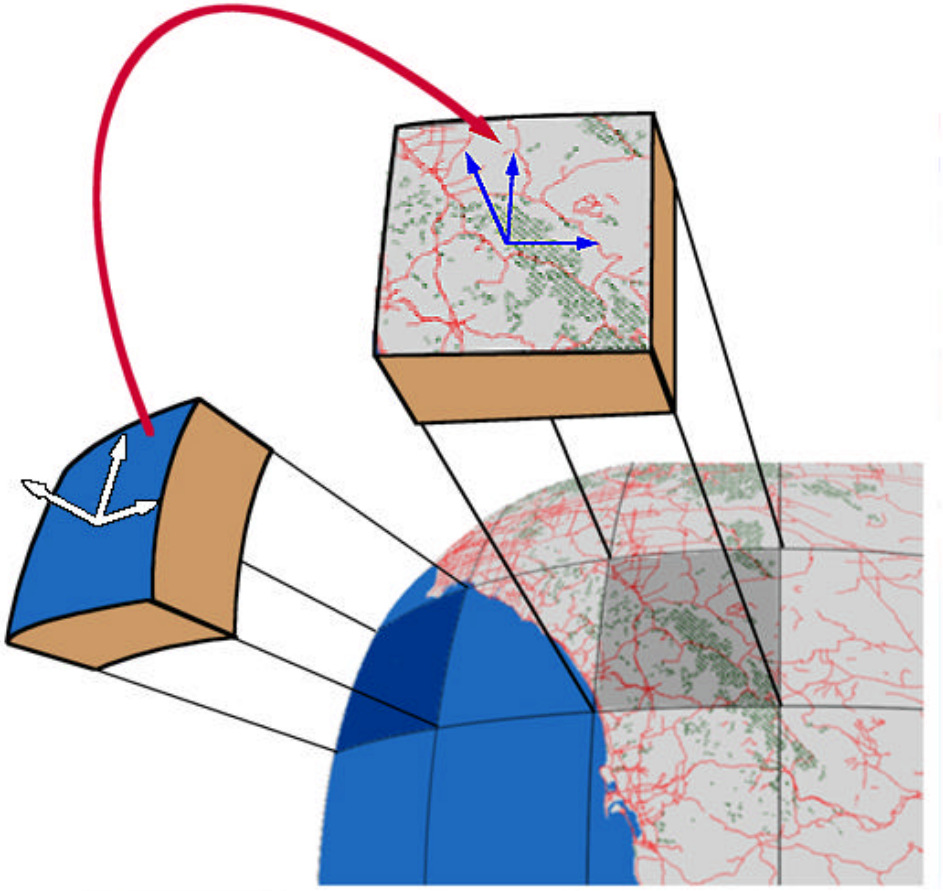


VIRTUAL GRIDS



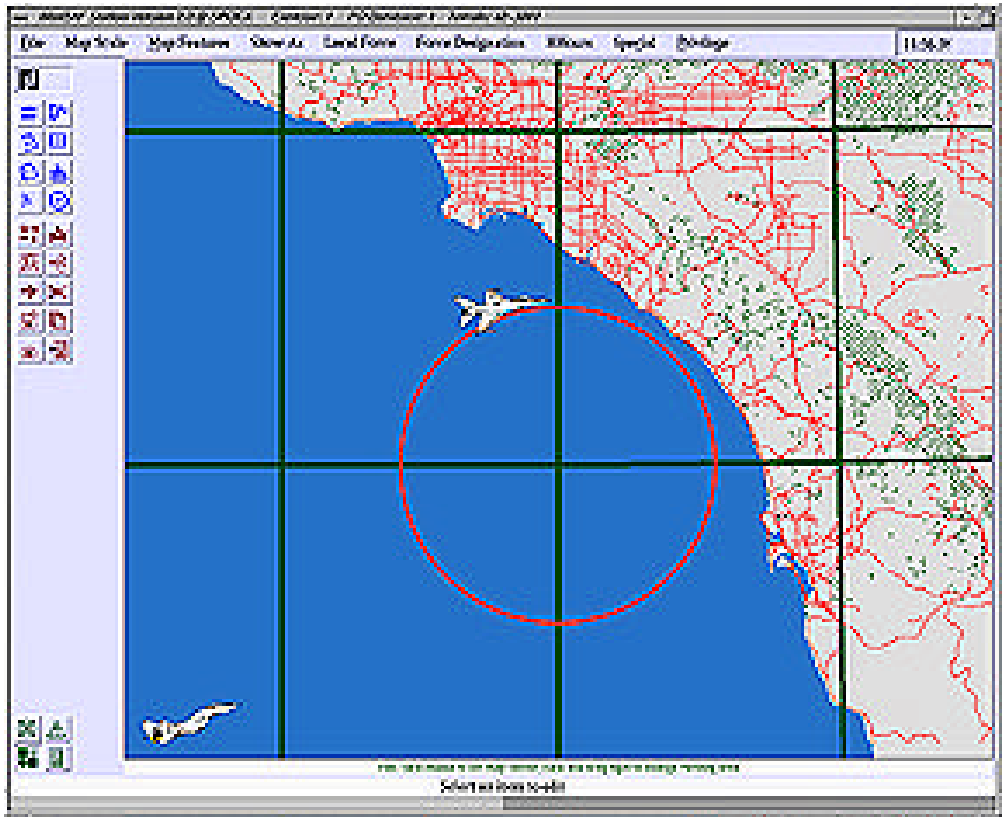
- Virtual grid overlaid on Terrain Elements
- Virtual grid based on number of TEs in patch
- Each grid mapped to 1 TE based on area intersection
- Each TE can be mapped to multiple virtual grids

GLOBAL COORDINATE SYSTEM



- Divide globe up into 1 degree cells, except at extreme latitudes
- Implement local cartesian coordinate system within cells (offset/ rotated GCC)
- Retain true elevation values, not projection
- Transformations between GCS and GCC are linear
- Transformations between cells are linear
- Cell locations based on World Geographic Reference (GEOREF) System

GLOBAL COORDINATE SYSTEM



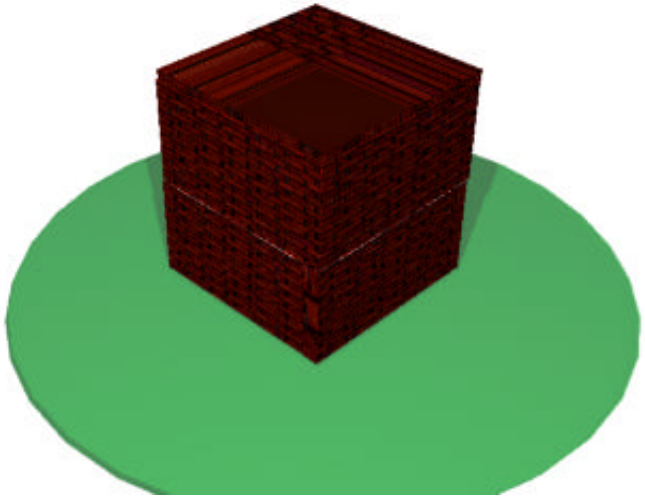
- **Multiple CTDBs allow variable resolution between GCS cells**
- **Some GCS cells could contain “virtual DBs”**

MULTIPLE ELEVATION SURFACES

- **Unified representation for buildings, bridges, caves, and tunnels**
  - **MES Structures**
  - **Similarities in geometry and LOS characteristics**
  - **New Volume Feature type with reference to complex 3D structures**
  - **Building interior and topology explicitly represented**
  - **Virtual grid extended to 3 dimensions**
  - **CTDB still supports simple volumetric buildings as well**

BUILDINGS IN CTDB

MES Structures



Simple Volume

TYPES OF MULTI-RES MODELING

- **There are three approaches to variable resolution modeling (*):**
  - **Selected viewing**
  - **Alternative submodels**
  - **Integrated hierarchical variable resolution (IVHR)**
- **Examples of all three approaches in CTDB**

(*) Davis and Huber, *Variable-Resolution Combat Modeling: Motivation, Issues and Principles,* RAND, N-3400-DARPA

SELECTED VIEWING

- **LADS added capability to ModSAF in response to performance problems in ED#1**
  - **Not part of ICTDB project**
- **Motivation was to boost performance in Plan View Display rendering as zoom level changes**
- **Multiple CTDB views are created at database compilation**
  - **Ground truth (default highest resolution) database is thinned for use when zoomed out**
  - **No user choice in selections available during use**

ALTERNATIVE SUBMODELS

- **Multiple level of detail three dimensional models**
  - **SIMNET and DIS have always supported multiple LOD models**
  - **IG viewing range determines which LOD is selected**
- **Default model for buildings in CTDB is a simple roofline geometry / footprint description**
- **ICTDB has added Multiple Elevation Surface (MES) structure models for buildings**
  - **Complex building geometry and interior topology (enclosures and apertures)**
- **Software decides whether to use coarse geometry or detailed model based on function**

PROTOTYPES FOR IVHR

- **ICTDB has added two ways of making inset regions of high resolution**
- **Global Coordinate System is based on tiling the playbox into cells**
  - **Some cells could be course level of resolution (grid)**
  - **Cells in area of interest could be high resolution (TIN)**
- **Hybrid data bases are now supported**
  - **Local patches can be grids or TINs**
  - **Transition patches address consistency mechanism**
- **Both GCS and hybrid databases are static and have no concurrent levels of resolution, but basic technology advances have been made**

PROTOTYPES FOR IVHR

- ITIN work added a key piece functionality - the virtual grid
- Resolution of grid used for storage and retrieval of TIN data is tied to triangle density
- This bounds the complexity of the point location algorithm - key step in using TIN data
- Permits arbitrary resolution in terrain data
- Same idea used in 3D in implementing MES structures

FUTURE WORK

- **Software mechanism to support concurrent levels of resolution (ivHr) must be developed**
- **Consistency (Ivhr) is the hard part since we are dealing with geometry and ground truth**
- **Process for populating IVHR SE models must be developed**
- **Levels of resolution in the hierarchy must meet force modeling requirements**
- **Potential requirement for dynamic levels of resolution (iVhr) will pose real challenges**
- **These are the JSIMS challenges for ICTDB and other modelers of the Synthetic Environment**